

Characterization of Potential Adverse Health Effects Associated with Consuming Fish and Blue Crabs from

Galveston Bay



Advisory History

- 1990
 - Consumption advisory (ADV-3) issued for the Houston Ship Channel and all contiguous waters and Upper Galveston Bay due to the presence of dioxins in catfish and blue crabs.
- 2001
 - Consumption advisory (ADV-20) issued for the Houston Ship Channel upstream of the Lynchburg Ferry crossing and all contiguous water including the San Jacinto River below the U.S. 90 bridge due to the presence of pesticides and PCBs in all species of fish.
- 2004
 - Consumption advisory (ADV-28) issued for the Houston Ship Channel and Upper Galveston Bay due to the presence of PCBs in spotted seatrout.

What prompted the 2006-2007 Galveston Bay study?



- The results of the 2004 HSC and Upper Galveston Bay study revealed that spotted seatrout contain PCBs at concentrations of public health concern. As a result of this finding, DSHS issued ADV-28 recommending limited consumption of spotted seatrout from the HSC and Upper Galveston Bay.
- The 2004 study conclusions also recommended additional fish tissue monitoring to determine if PCBs are found in spotted seatrout tissues throughout the Galveston Bay system at concentrations of public health concern. Data from this most recent risk characterizations along with historical Texas gulf coast data indicate that spotted seatrout have a tendency to bioaccumulate PCBs. In addition, Texas Parks and Wildlife Department (TPWD) tagging data indicate that spotted seatrout move throughout the entire Galveston Bay System.

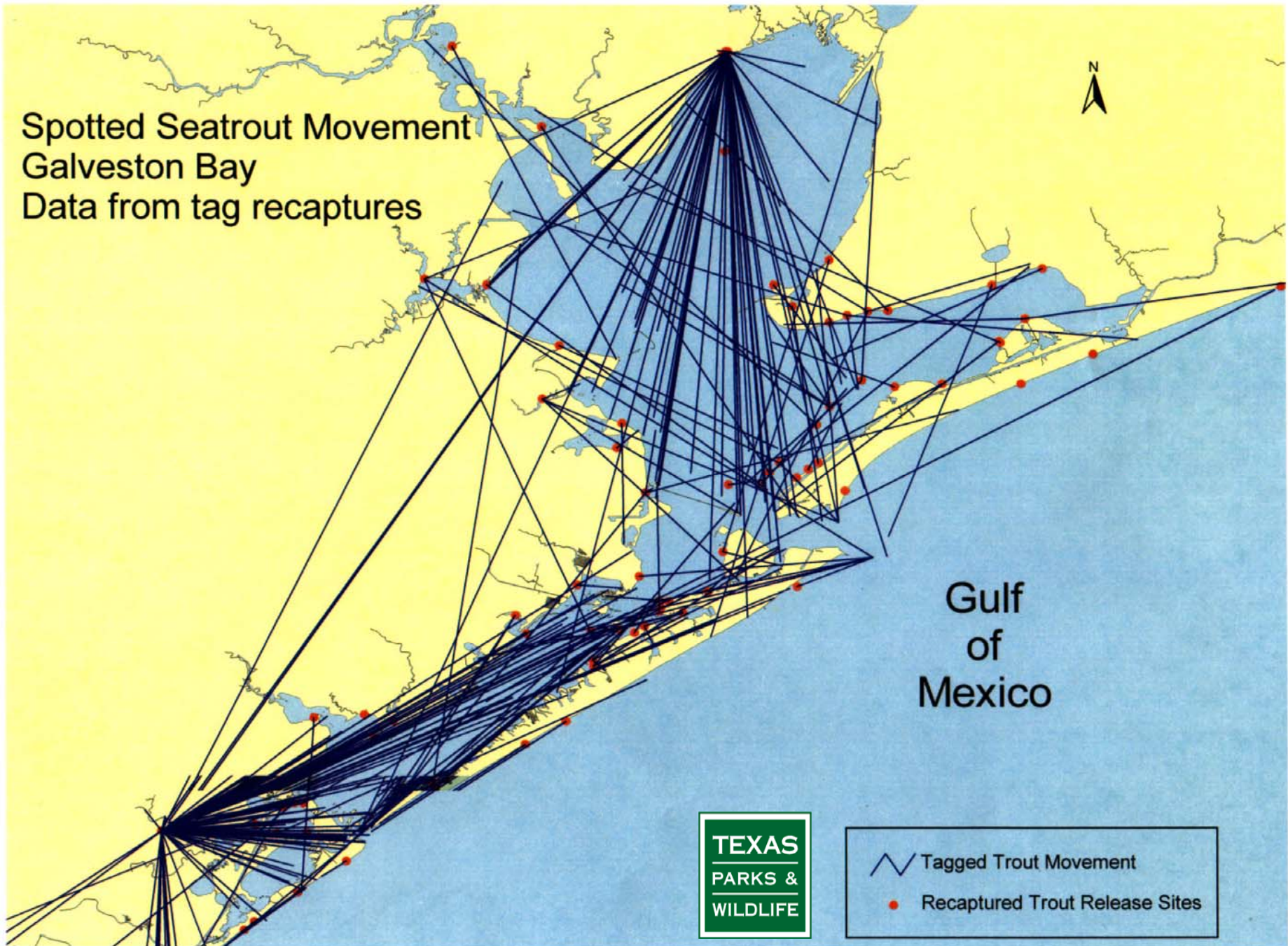
Spotted Seatrout Movement
Galveston Bay
Data from tag recaptures



Gulf
of
Mexico

TEXAS
PARKS &
WILDLIFE

-  Tagged Trout Movement
-  Recaptured Trout Release Sites



Project Objectives

- To continue progress in the development of a routine seafood monitoring program for Galveston Bay as a component of the *Galveston Bay Plan* to reduce potential health risks resulting from consumption of chemically contaminated seafood.
- To determine the extent of spotted seatrout PCB contamination in the Galveston Bay system.



Sample Design

- **Two Study Areas**
 - **Study Area 1 (Galveston Bay south of Five Mile Cut Marker and north of a line drawn from Eagle Point to Smith Point including Trinity Bay)**
 - **Study Area 2 (Lower Galveston Bay excluding East and West Bays)**

Target Species

- **Spotted seatrout**
- **Black drum**
- **Gafftopsail catfish**
- **Red drum**
- **Southern flounder**
- **Blue crab**

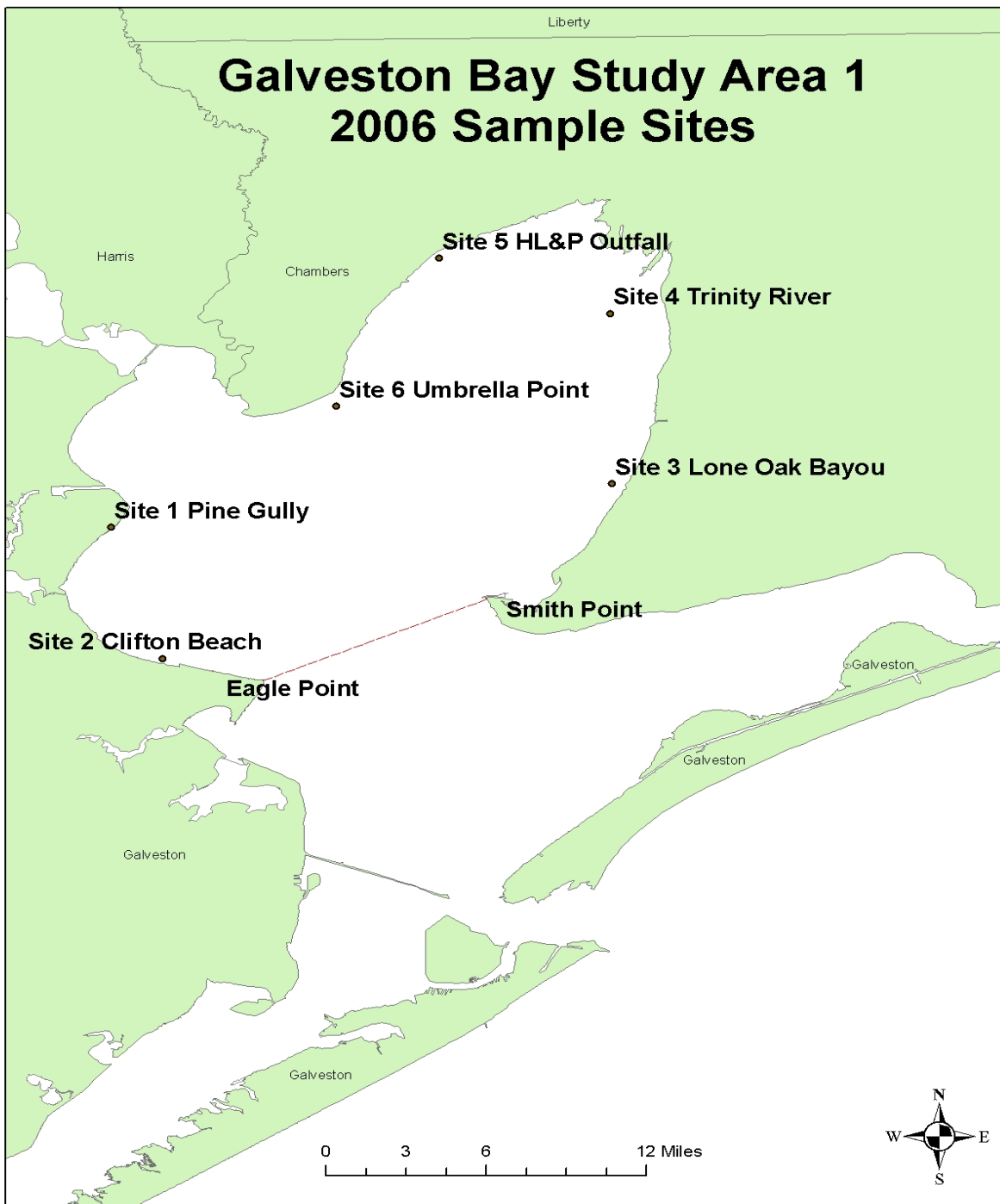


Target Analytes

- **Metals** (arsenic, cadmium, copper, lead, mercury, selenium, and zinc)
- **Pesticides** (34)
- **PCBs** (209 congeners)
- **SVOCs** (123)
- **VOCs** (70)
- **PCDDs/PCDFs** (17 congeners)

Sample Sites, Study Area 1

- Site 1 Pine Gully
- Site 2 Clifton Beach / Clifton Channel
- Site 3 Lone Oak Bayou
- Site 4 Trinity River Mouth
- Site 5 Houston Light and Power Outfall
- Site 6 Umbrella Point



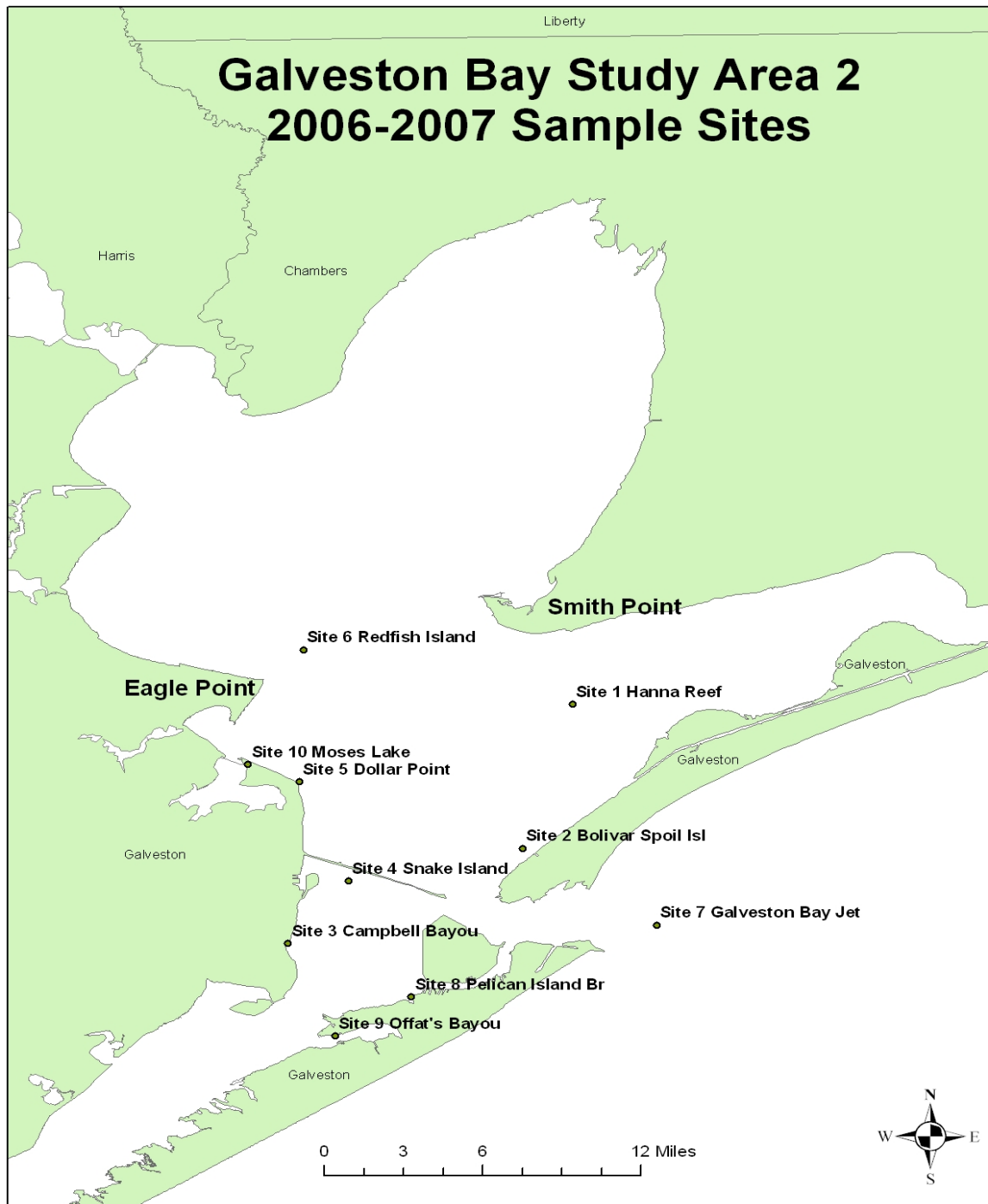
Samples Collected, Study Area 1

Site	Number of Samples	Spotted seatrout	Red drum	Black drum	Gafftopsail catfish	Southern flounder	Blue crab
Pine Gully	18	9	1	2	3	1	2
Clifton Beach	22	14	0	1	3	2	2
Lone Oak Bayou	10	1	3	1	2	1	2
Trinity River Mouth	8	3	1	1	2	1	0
Houston Light and Power Outfall	52	41	1	1	4	1	4
Umbrella Point	12	3	1	2	3	1	2
Total (122)	122	71	7	8	17	7	12

Sample Sites, Study Area 2

- Site 1 Hanna Reef
- Site 2 Bolivar Spoil Island
- Site 3 Campbell Bayou
- Site 4 Snake Island
- Site 5 Dollar Point
- Site 6 Redfish Island
- Site 7 Galveston Jetties
- Site 8 Pelican Island
- Site 9 Offat's Bayou
- Site 10 Moses Lake

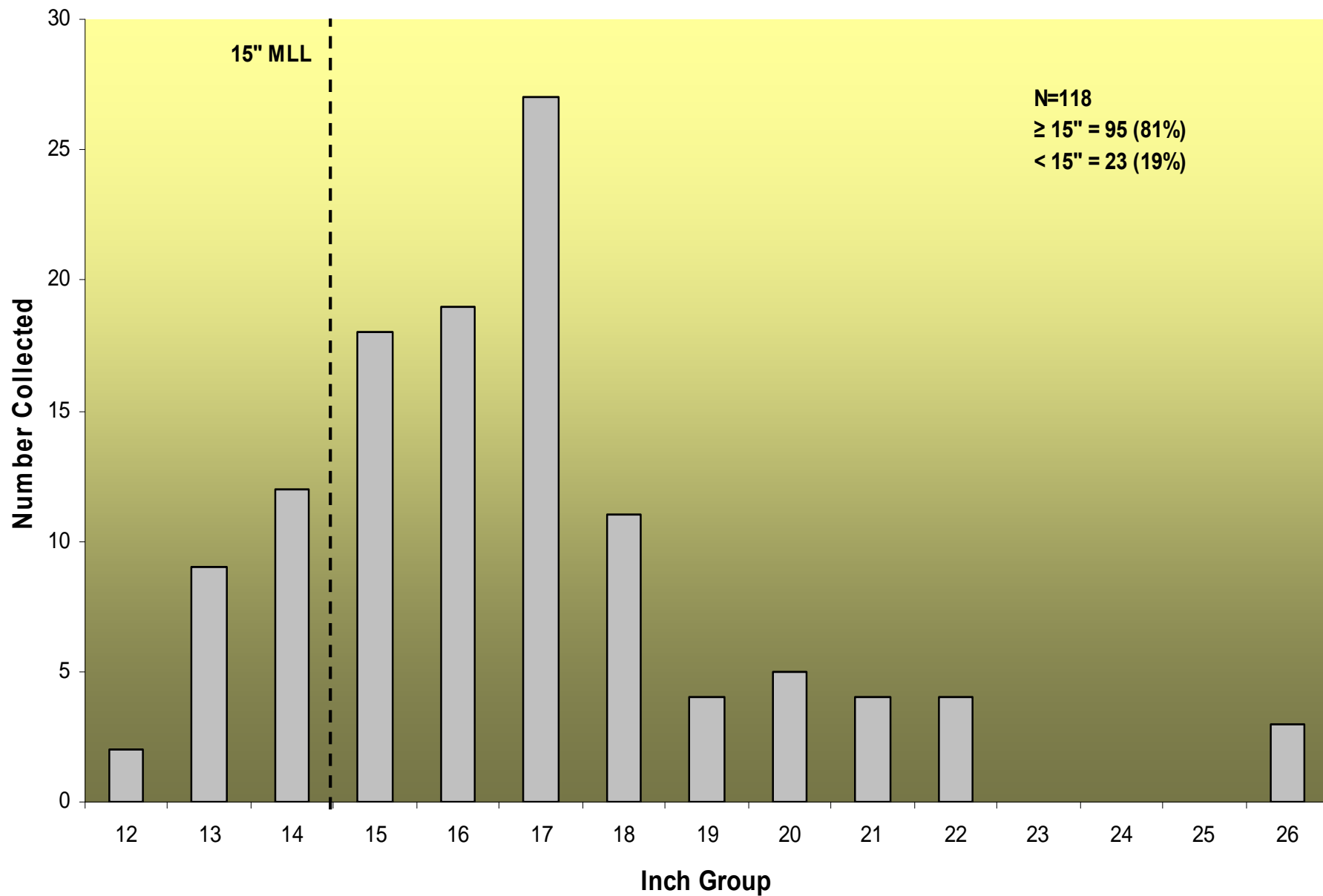
Galveston Bay Study Area 2 2006-2007 Sample Sites



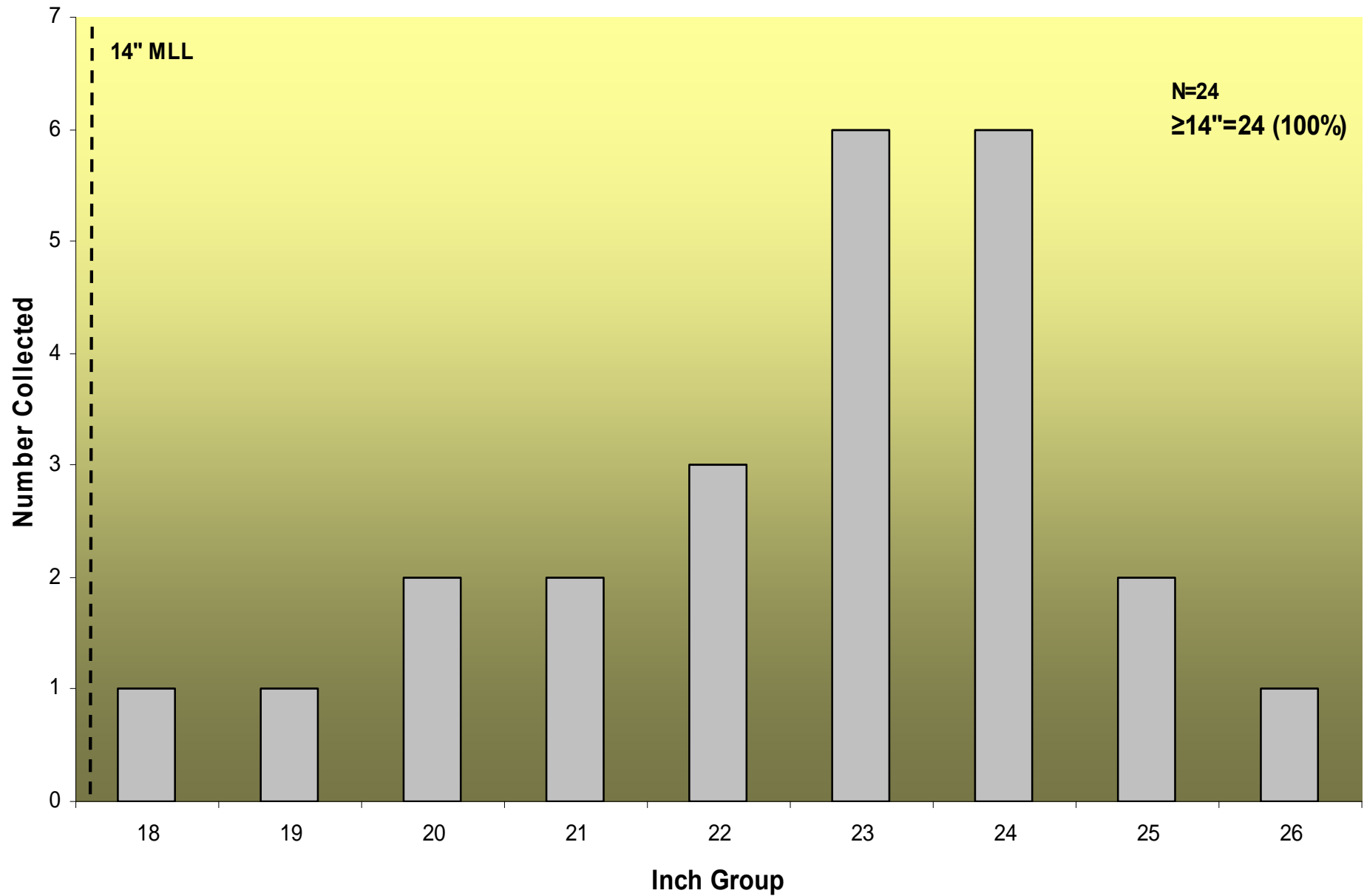
Samples Collected, Study Area 2

Site	Number of Samples	Spotted seatrout	Red drum	Black drum	Gafftopsail catfish	Southern flounder	Blue crab
Hanna Reef	6	0	2	2	0	0	2
Bolivar Spoil Island	17	10	1	1	1	1	3
Campbell Bayou	19	13	1	1	2	1	1
Snake Island	8	1	0	0	3	2	2
Dollar Point	12	7	1	1	0	1	2
Redfish Island	7	3	1	1	1	1	0
Galveston Jetties	2	2	0	0	0	0	0
Pelican Island	2	2	0	0	0	0	0
Offat's Bayou	8	8	0	0	0	0	0
Moses Lake	1	1	0	0	0	0	0
Total (82)	82	47	6	6	7	6	10

Spotted Seatrout Sample Length Frequency (Trinity-Upper-Lower Galveston Bay)



Gaftopsail Catfish Sample Length Frequency (Trinity-Upper-Lower Galveston Bay)



Inorganic Contaminants “Metals” Detected in Galveston Bay Seafood Samples

- Arsenic
- Cadmium
- Copper
- Lead
- Mercury
- Selenium
- Zinc

Organic Contaminants Detected in Galveston Bay Seafood Samples

- **PCBs**
- **PCDDs/PCDFs**
- Pesticides
 - chlordane, dieldrin, endosulfans, pentachloroanisole, pentachlorobenzene, hexachlorobenzene, various DDT derivatives, and mirex)
- SVOCs
 - phthalate esters, acenaphthene, fluorine, and phenol
- VOCs
 - acetone, methylene chloride, 1,2-dichloroethane, acrolein, benzene, toluene, and naphthalene

DSHS Risk Calculation Assumptions

- Standard Adult Weight = 70 kg (154 lb)
- Adult Consumption Rate = 0.030 kg/day
 - Equivalent to one eight ounce fish meal per week
- Acceptable Risk Level (ARL)
 - 1 in 10,000 persons equally exposed
- Exposure Period = 30 years

EPA Reference Dose (RfD)

- An estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

$$\text{RfD} = \text{NOAEL or LOAEL} / \text{UF} \times \text{MF}$$

Health Assessment Comparison Values (HACs)

"HACs do not represent a sharp dividing line between safe and unsafe exposures; HACs are primarily a tool used to make risk management decisions that assure protection of public health."

- Systemic (noncancerous) effects

- $HAC_{nonca} = RfD \text{ or } MRL \times BW / CR$

- Cancerous effects

- $HAC_{ca} = ((ARL / CSF) \times BW) / CR$

PCBs, Study Area 1

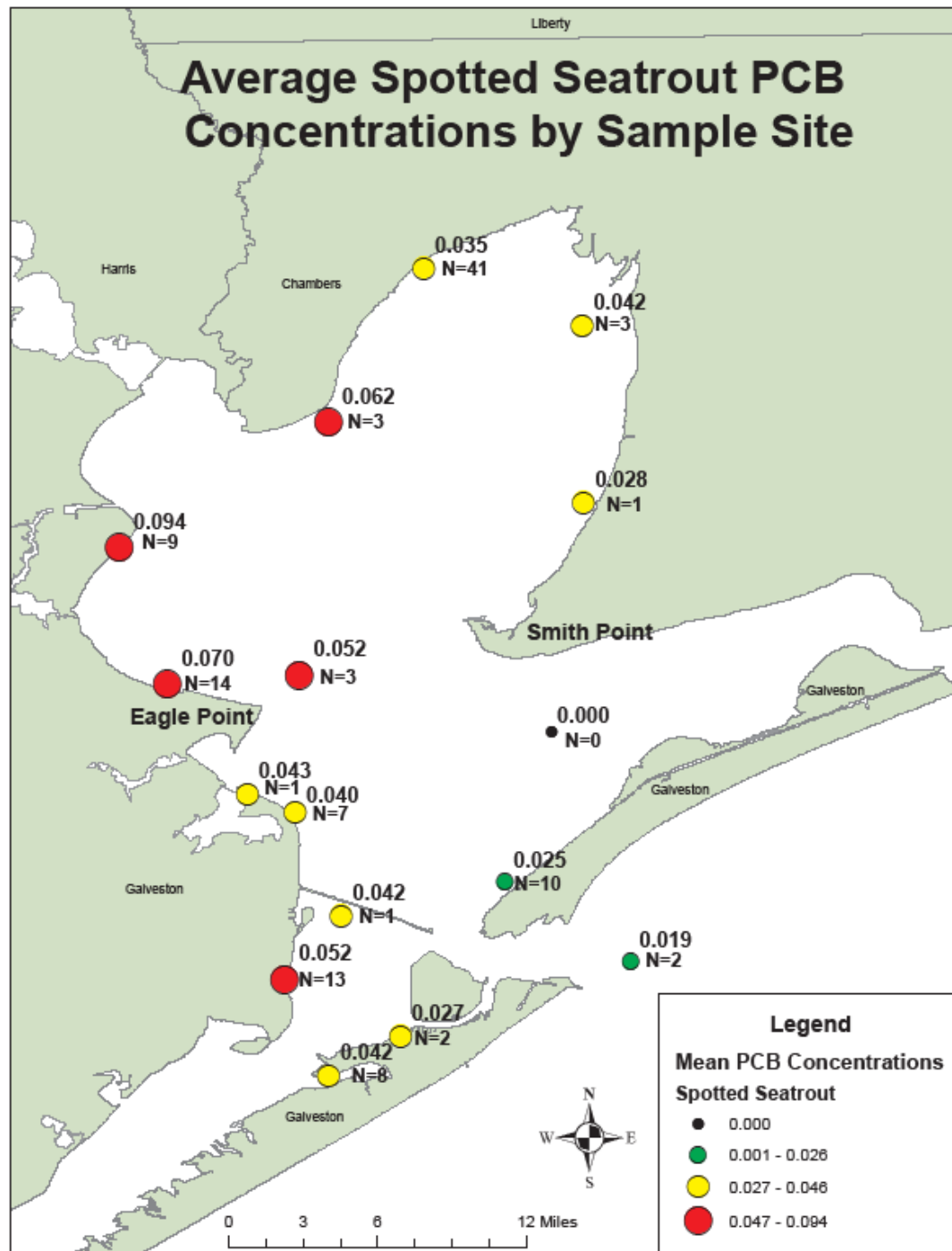
Species	# Detected/ # Sampled	Mean Concentration (mg/kg)	Health Assessment Comparison Value (mg/kg)
Black drum	8/8	0.013±0.005 (0.010-0.024)	0.047 (noncancer) 0.270 (cancer)
Blue crab	12/12	0.010±0.0004 (0.009-0.010)	
Gaftopsail catfish	17/17	0.099±0.066 (0.039-0.305)	
Red drum	7/7	0.016±0.006 (0.010-0.027)	
Southern Flounder	7/7	0.012±0.004 (0.010-0.020)	
Spotted seatrout	71/71	0.051±0.032 (0.017-0.189)	
All Fish	110/110	0.051±0.044 (0.010-0.305)	
All Species	122/122	0.047±0.044 (0.009-0.305)	

PCBs, Study Area 2

Species	# Detected/ # Sampled	Mean Concentration (mg/kg)	Health Assessment Comparison Value (mg/kg)
Black drum	6/6	0.011±0.001 (0.001-0.013)	0.047 (noncancer) 0.270 (cancer)
Blue crab	8/10	0.011±0.002 (ND-0.017)	
Gaftopsail catfish	7/7	0.097±0.014 (0.077-0.113)	
Red drum	6/6	0.013±0.004 (0.010-0.027)	
Southern Flounder	6/6	0.024±0.014 (0.010-0.048)	
Spotted seatrout	47/47	0.040±0.030 (0.009-0.155)	
All Fish	72/72	0.039±0.033 (0.009-0.155)	
All Species	80/82	0.036±0.032 (ND-0.155)	

PCBs, Study Areas Combined

Species	# Detected/ # Sampled	Mean Concentration (mg/kg)	Health Assessment Comparison Value (mg/kg)
Gaftopsail catfish	24/24	0.098 ±0.055 (0.039- 0.305)	0.047 (noncancer) 0.270 (cancer)
Spotted seatrout	118/118	0.046±0.032 (0.009- 0.189)	



PCDDs/PCDFs, Study Area 1

Species	# Detected/ # Sampled	Mean Concentration (TEQs-pg/g)	Health Assessment Comparison Value (pg/g)
Black drum	6/6	0.1922±0.4221 (0.0003-1.0500)	2.33 (noncancer) 3.49 (cancer)
Blue crab	10/12	0.0350±0.0580 (ND-0.1677)	
Gaftopsail catfish	14/14	2.5124±3.8544 (0.0036-15.4675)	
Red drum	6/6	0.0504±0.0837 (0.0002-0.2002)	
Southern Flounder	5/5	0.0322±0.0413 (0.0002-0.1000)	
Spotted seatrout	12/12	1.0555±0.9698 (0.0302- 2.6805)	
All Fish	43/43	1.1501±2.4373 (0.0002- 15.4675)	
All Species	53/55	0.9068±2.1993 (ND- 15.4675)	

PCDDs/PCDFs, Study Area 2

Species	# Detected/ # Sampled	Mean Concentration (TEQs-pg/g)	Health Assessment Comparison Value (pg/g)
Black drum	0/2	ND	2.33 (noncancer) 3.49 (cancer)
Blue crab	1/2	0.0661±0.0934 (ND-0.1321)	
Gaftopsail catfish	4/4	1.3986±1.5510 (0.1652-3.4839)	
Red drum	1/2	0.0060±0.0084 (ND-0.0119)	
Southern Flounder	1/1	0.0011	
Spotted seatrout	5/5	0.9811±1.4451 (0.0007-3.3090)	
All Fish	11/14	0.7509±1.2500 (ND-3.4839)	
All Species	12/16	0.6653±1.1872 (ND-3.4839)	

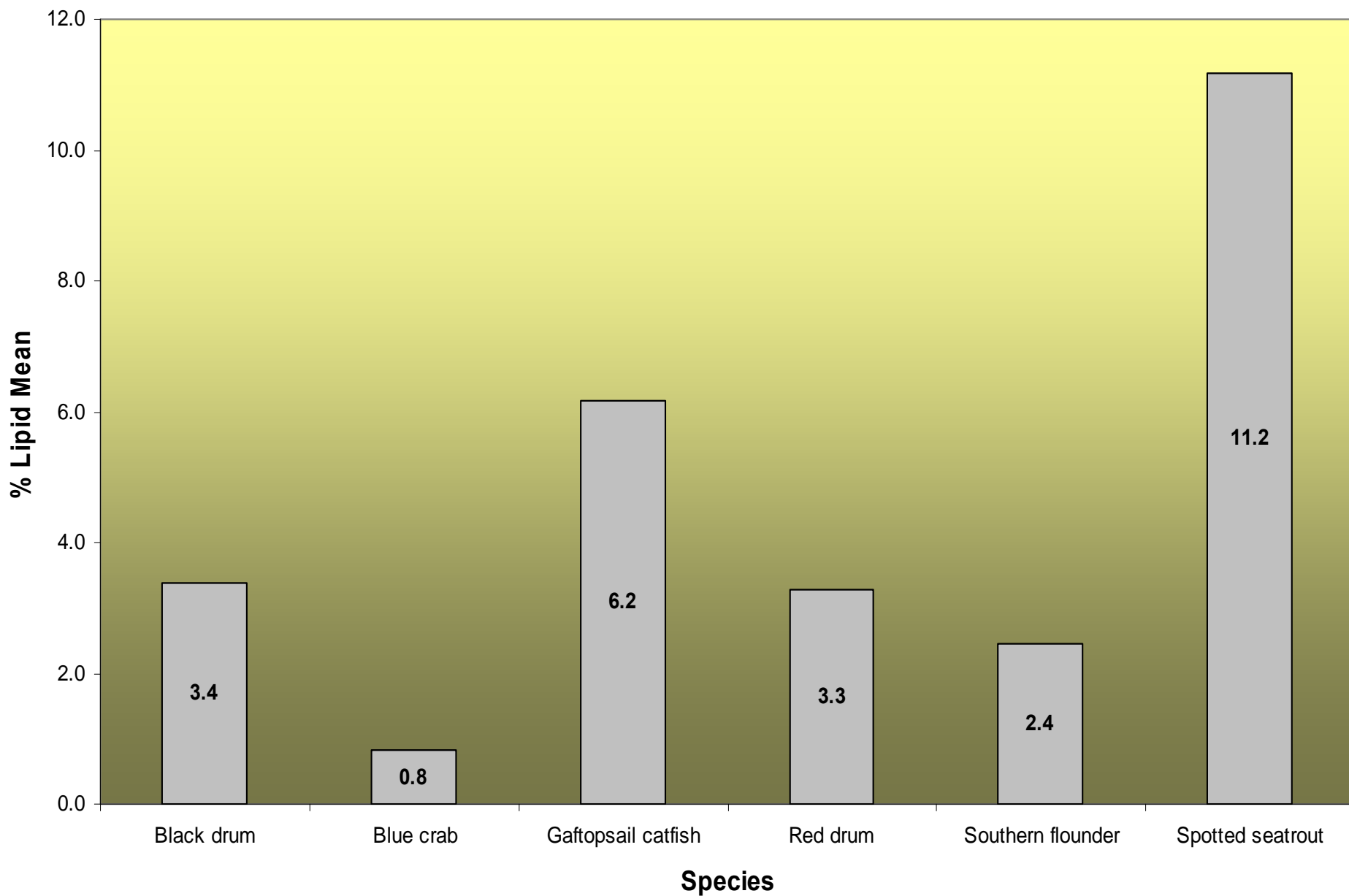
PCDDs/PCDFs, Study Areas Combined

Species	# Detected/ # Sampled	Mean Concentration (TEQs-pg/g)	Health Assessment Comparison Value (pg/g)
Gaftopsail catfish	18/18	2.2649±3.4659 (0.0036-15.4675)	2.33 (noncancer) 3.49 (cancer)
Spotted seatrout	17/17	1.0336±1.0816 (0.0007-3.3090)	

Percent Lipid "Fat"

Species	% Lipid Mean
Black drum	3.4 ± 2.8 (0.5-8.1)
Blue crab	0.8 ± 0.4 (0.0-1.5)
Gaftopsail catfish	6.2 ± 3.3 (0.7-13.2)
Red drum	3.3 ± 3.3 (0.6-10.2)
Southern Flounder	2.4 ± 1.9 (0.4-6.0)
Spotted seatrout	11.2 ± 6.8 (0.1-28.3)

Percent Lipid Mean by Species



What is a Hazard Quotient?

- A hazard quotient (HQ) is the ratio of the estimated exposure dose of a contaminant to its RfD or MRL.
 - $HQ = ((MCC \times CR) / BW) / RfD$
- Systemic (noncancer) health effects are unlikely from consumption of fish for which the HQ is less than 1.0.

Hazard Quotients (HQ's) and Hazard Indices (HI's) for PCBs and PCDDs/PCDFs and Suggested Adult Consumption Rate

Species/Contaminant	Hazard Quotient	Meals per Week
Gaftopsail Catfish		
PCBs	2.11	0.4
PCDDs/PCDFs	1.14	0.8
Hazard Index (meals/week)	3.25 (0.3)	
Spotted Seatrout		
PCBs	0.99	0.9
PCDDs/PCDFs	0.44	2.1
Hazard Index (meals/week)	1.44 (0.6)	

Theoretical Lifetime Excess Cancer Risk

Species/Contaminant	Cancer Risk	Meals per Week
Gaftopsail Catfish		
PCBs	1 in 28,160	2.6
PCDDs/PCDFs	1 in 24,955	2.3
Cumulative Theoretical Lifetime Excess Cancer Risk (meals/week)	1 in 13,230 (1.2)	
Spotted Seatrout		
PCBs	1 in 68,040	6.3
PCDDs/PCDFs	1 in 35,574	3.3
Cumulative Theoretical Lifetime Excess Cancer Risk (meals/week)	1 in 23,360 (2.2)	

Public Health Implications

- Consumption of catfish and spotted seatrout from Galveston Bay poses an apparent hazard to public health.
- Regular or long-term consumption of catfish and spotted seatrout from Galveston Bay exceeding recommended consumption limits may result in systemic adverse health effects including immunologic, neurologic, reproductive, or developmental abnormalities.

Recommendations

- That DSHS extends extant consumption advice that presently covers the Houston Ship Channel and contiguous waters to include all catfish species and spotted seatrout from Galveston Bay because these species contain PCBs and/or PCDDs/PCDFs at levels that could increase the risk of adverse systemic health effects or, in some instances cancer in those who regularly consume these species.
- That DSHS advises people that it is not necessary to limit consumption of black drum, red drum, southern flounder, or blue crab from Galveston Bay.
- That the DSHS continues to monitor seafood from Galveston Bay for changes in contaminants or in contaminant concentrations that would necessitate a change in consumption advice for fish or shellfish from these waters.

Public Health Action

- ADV-35 issued July 8, 2008 recommended that
 - Persons should limit consumption of all catfish species and spotted seatrout from Galveston Bay to no more than one eight-ounce meal per month.
 - Women who are nursing, pregnant, or who may become pregnant and children should not consume catfish and spotted seatrout from Galveston Bay.

TEXAS DEPARTMENT OF STATE HEALTH SERVICES

FISH AND SHELLFISH CONSUMPTION ADVISORY

ADV-35

This advisory is issued as a result of sampling of Trinity Bay and Upper and Lower Galveston Bay in Chambers, Galveston, and Harris Counties. Gaftopsail catfish and spotted seatrout collected from Trinity Bay and Upper and Lower Galveston Bay indicates the presence of polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDDs/PCDFs or "Dioxin") and polychlorinated biphenyls (PCBs) at concentrations exceeding health assessment guidelines established by the Texas Department of State Health Services (DSHS). Consumption of catfish species and spotted seatrout from Galveston Bay may pose a threat to human health.

COUNTY:	Brazoria, Chambers, Galveston, and Harris Counties
AREA:	Galveston Bay including Chocolate Bay, East Bay, West Bay, Trinity Bay and contiguous waters.
SPECIES AFFECTED:	All catfish species and spotted seatrout
CONSUMPTION ADVISORY:	Persons should limit consumption of catfish and spotted seatrout from this area to no more than one eight-ounce meal per month. Women who are nursing, pregnant, or who may become pregnant and children should not consume catfish or spotted seatrout from these waters.

This advisory shall remain in effect until rescinded or modified in writing.

Issued this 8th day of July, 2008



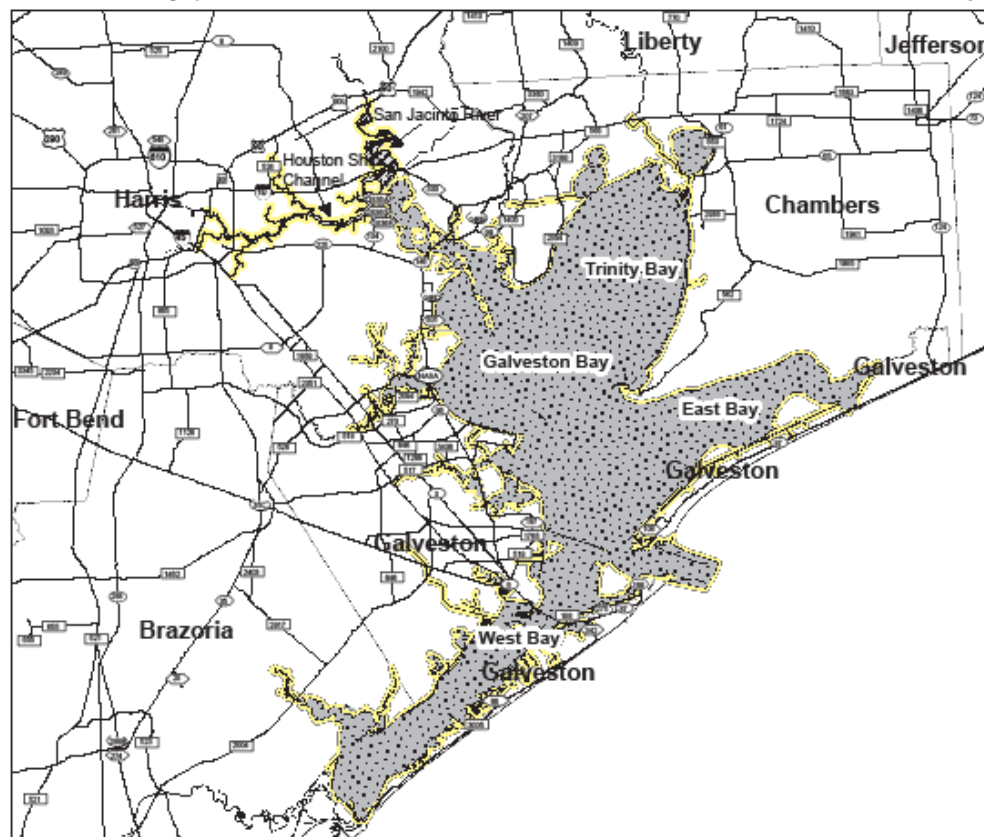
David L. Lahey, M.D.
Commissioner

Houston Ship Channel and Galveston Bay

Brazoria, Chambers, Galveston, and Harris Counties

ADV-20 Issued October 9, 2001

ADV-35 Issued July 8, 2008



Advisory Areas:

Houston Ship Channel

The Houston Ship Channel upstream of the Lynchburg Ferry crossing and all contiguous waters, including the San Jacinto River below the U.S. Highway 90 bridge.

Galveston Bay

Galveston Bay including Chocolate Bay, East Bay, Trinity Bay, and West Bay and contiguous waters

Contaminants of Concern:

Dioxin, organochlorine pesticides, and PCBs

Dioxin and PCBs

Species Affected:

All species of fish

All catfish species and spotted seatrout



Consumption Advice:

Persons should limit consumption of all species of fish from this area to no more than one eight-ounce meal per month. Women who are nursing, pregnant, or who may become pregnant and children under 12 should not consume any species of fish from these waters.

Persons should limit consumption of catfish and spotted seatrout from this area to no more than one eight-ounce meal per month. Women who are nursing, pregnant, or who may become pregnant and children under 12 should not consume catfish or spotted seatrout.

Galveston Bay Future...?

- Potential long-term advisory?
- Additional monitoring
- Food-web studies
- Contaminant source studies

Michael Tennant
Texas Department of State Health Services
Seafood and Aquatic Life Group
512-834-6757
www.dshs.state.tx.us/seafood



Q: What are polychlorinated biphenyls (PCBs)?

A: PCBs are synthetic (man-made) mixtures of up to 209 individual chlorinated compounds (known as congeners). Many commercial PCB mixtures in the U.S. are known by the trade name Aroclor. PCBs are oily liquids or solids that are colorless to yellow. Some PCBs may also exist as a vapor in air. PCBs were once used commercially as coolants and lubricants in electrical transformers and capacitors, heavy-duty electrical equipment in power plants, industries, and large buildings across the country and other electrical equipment, carbonless copy papers, sealing and caulking compounds, paint additives, cutting oils, ballasts in fluorescent light fixtures, and hydraulic fluids. PCBs were valued for chemical stability and fire resistance.

Q: How do PCBs enter the environment?

A: In 1979, The United States Environmental Protection Agency (USEPA) banned the manufacture of PCBs in the United States. However, the USEPA did not require removal of PCB-containing materials still in service at the time of the ban. Therefore, some materials remain in use today. The major source of environmental PCBs in the United States today is from ongoing use, storage, and disposal of products in landfills or improper disposal of products that contain PCBs. PCBs also may be released from sediments disturbed by flooding, dredging, and other activities.

Q: What are dioxins?

A: Dioxins are a group of synthetic organic chemicals that contain 210 structurally related individual polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). In pure form, dioxins are crystals or colorless solids. Dioxins are primarily produced as unintentional byproducts of chlorine bleaching in pulp and paper mills, municipal solid waste and industrial waste incineration, combustion of fossil fuels and wood, waste and drinking water chlorination, and as contaminants in the manufacture of certain organic chemicals. Dioxins are also natural products of forest fires and possibly other natural processes, but these sources are small compared to dioxins produced by human activity.

Q: How do dioxins enter the environment?

A: Currently, the major environmental source of dioxins is incineration. Dioxins are highly persistent in the environment due to their very low water solubility and low volatility. Most are contained in soil and sediments that serve as environmental reservoirs from which dioxins may be released over a long period of time. Particle resuspension from environmental reservoirs is an important contributor to dioxin distribution.

Q: How do dioxins and PCBs accumulate in fish?

A: Dioxins and PCBs have been found in soil, ground and surface water, air, sediment, plants, and animals in all regions of the world. Dioxins and PCBs break down very slowly in the environment and accumulate in fatty tissue, skin, and internal organs of fish and other animals. Levels of dioxins and PCBs in fish may be hundreds to a million times higher than the concentrations found in water or sediments. The amount of dioxins and PCBs found in fish varies with species, age, size, fat content, diet, and surface water and sediment concentrations. Generally, Larger, older fish will contain higher levels of dioxins and PCBs than smaller, younger fish; fatty fish such as spotted seatrout and catfish species may contain higher levels of dioxins and PCBs than lean fish such as southern flounder, red drum, and black drum.

Q: Why do gaftopsail catfish and spotted seatrout accumulate higher levels of dioxins and PCBs than other Galveston Bay sport fish?

A: Generally, dioxin and PCB level differences can occur between fish species because of higher lipid "fat" levels, dietary differences, and/or feeding locations in Galveston Bay.

Q: How can dioxins and PCBs affect my health?

A: Eating fish that contain dioxins and PCBs may cause skin conditions such as acne and rashes. Dioxins and PCBs may also affect the immune system, reproductive system, liver, delay physical and neurological development, and may increase the risk of cancer.

Q: What is the source of dioxins and PCBs in Galveston Bay?

A: DSHS does not attempt to determine contaminant sources. The Texas Commission on Environmental Quality (TCEQ) is the state agency responsible for identifying contaminant sources.



Q: Should I be concerned about dioxins and PCBs while participating in contact recreation activities like boating or swimming?

A: There is not a health concern for dioxins and PCBs while swimming or other contact recreational activities. Levels in the water are low. The concern is for consumption of fish that concentrate the dioxins and PCBs in their tissue.

Q: Will the Galveston Bay fish consumption advisory be long term?

A: Dioxins and PCBs are contaminants that persist in the environment for years. Due to the long-lived nature of these contaminants there is a strong likelihood that the Galveston Bay fish consumption advisory could be long term.

